Test and Evaluation of the Doppler Volume Sampler (DVS) Acoustic Doppler Current Profile (ADCP)

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Abstract **-** Teledyne RD Instruments has recently released a new high frequency Acoustic Doppler Current Profiler (ADCP), the Doppler Volume Sampler (DVS). The DVS is intended for use in applications where single point current meters are currently used. To evaluate the performance of the DVS, it was deployed on the same taught wire mooring near two current meters. In addition to comparing the results from the DVS and the two single point current meters, a summary of the results from the various data quality parameters from the DVS are used to evaluate performance of the DVS**.**

I. Reason for Testing

Teledyne RD Instruments (TRDI) has been manufacturing Acoustic Doppler Current Profilers (ADCP) for measurement of current speed and direction with quality assurance at multiple ranges from the instrument since 1982. Recently, TRDI produced a new ADCP, the Doppler Volume Sampler (DVS) that uses a very high frequency (2400kHz) broadband transmission for measuring currents over a very short range (<5 meters). The physical beam orientation of the DVS was optimized at 45 degrees off of vertical to avoid acoustic interaction with the influences of flow interference from taught wire moorings. This test was designed to verify that the DVS produces reliable measurements relative to a historical standard and a newer Doppler type current measurement when deployed on a taught wire mooring.

II. Mooring Design

The DVS and two other current measurement devices were deployed within 3 meters of each other on a taught wire mooring by the Bedford Institute of Oceanography at BIO's Halifax test site. Figures 1 and 2 depict the mooring design and the deployment location.

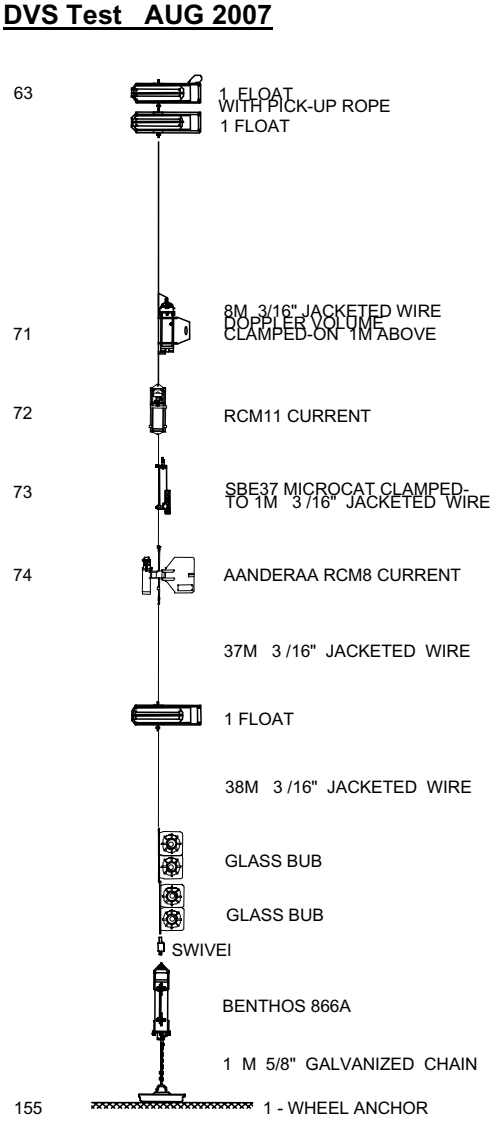

Fig. 1: Mooring Schematic

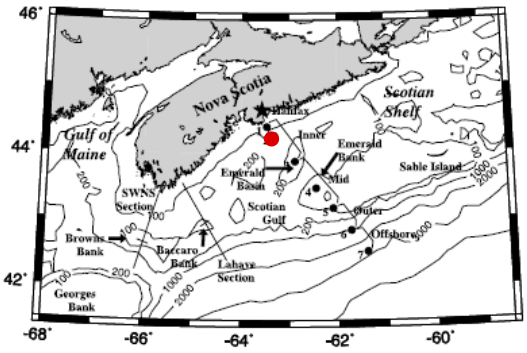

Fig. 2: Mooring Deployment Location (red dot)

Table 1 contains a comparison of the three instrument configurations:

The mooring was deployed for a period of 57 days starting on August 8th, 2007.

	DVS	*RCM11*	*RCM8*
Meas. Type	Broad Band Doppler Current Profiler	Narrow Band Doppler Current Meter	Mechanical Rotor
Meas. "ensemble" Interval	2.5 Minutes	20 Minutes	20 Minutes
# 0.5 M Cells in the current Profile	5	1	NA
# Samples / Measurement	1	50	300
Sample Duration	1 second	1 second	1 second
Number of Pings / Sample	14	NA	NA
Predicted Instrument Standard Deviation	0.5 cm/sec	<1 cm/sec	<1 cm/sec
Battery Life as Configured	> 3 years	1 year	1 year

Table 1: Instrument Setups

The acoustic backscatter at the deployment site was very low and the DVS was only able to achieve 4x cells occasionally and 3x cells reliably during the deployment. A time series of the velocity profile for a portion of the deployment is detailed in Figure 3.

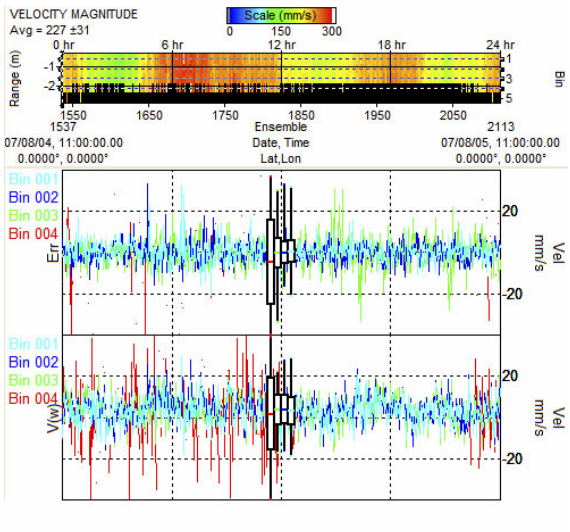

Figure 3: DVS Measured Speed (contour), Error and Vertical Velocities (time series)

Error velocity from a 4x beam Doppler is indicative of the flow homogeneity and the measurement variance. Since cell three had elevated error velocity measurements, it was not included in subsequent analysis. The time series of current speed from all three instruments within a 24 hour averaging window are detailed in Figures 4 and 5 respectively. The single velocity from the DVS is the average from cells 1 and 2.

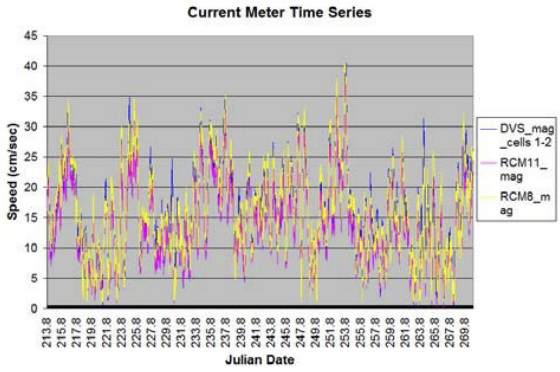

Figure 4: Time Series of Velocity from all three Current Meters

A scatter plot of the measured velocities from the DVS and the RCM11 relative to the RCM8 is detailed in Figure 6. A plot of the 24 hour averaged data is contained in Figure 7. Both the Doppler based instruments were compared to the RCM8 because it was considered by many to be the "historical standard" single point current meter. As evident by the < unity slopes of linear curve fits for both the DVS and the RCM11, both systems read low relative to the RCM8.

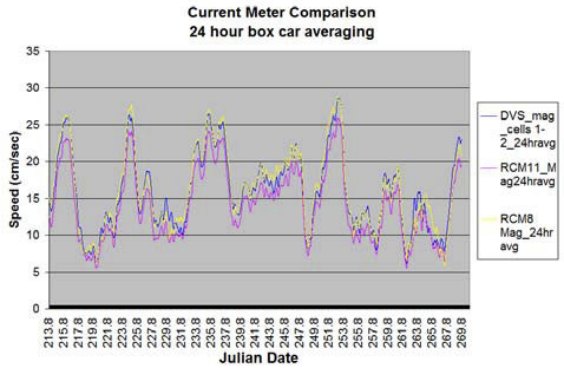

Figure 5: 24 hour moving average of Velocity from all three Current Meters.

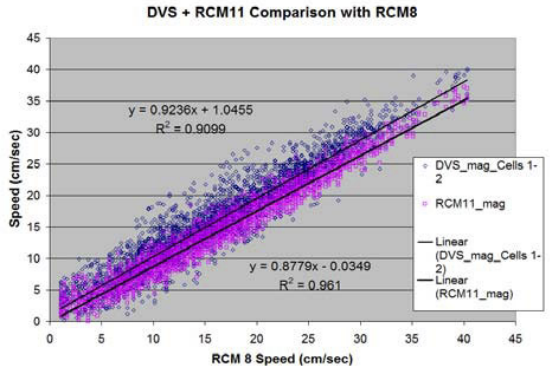

Figure 6: Scatter Plot of DVS and RCM11 data relative to RCM8.

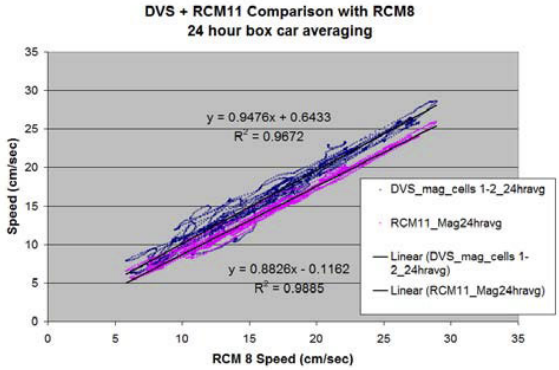

Figure 7: Scatter Plot of DVS and RCM11 data relative to RCM8 – 24 hour average.

A comparison of the average velocities from each of the current meters and standard deviations from the three instruments are detailed in Table 2.

	DVS	*RCM11*	*RCM8*
Average Velocity (cm/sec)	16.02 *	14.20	16.22
Standard deviation of the Velocity time series over a 58 day duration (cm/sec)	7.21	6.66	7.44

Table 2: Summary Results

* NOTE: This was an average from DVS Cells 1 and 2

The advantage of using a profiling ADCP on a mooring is that you can evaluate the potential for flow disturbances from eddies that are shedd off of the mooring line itself. The magnitude of the shear between cells 1 and 2 from 24 hour averaged velocities were calculated and compared to the difference between the 24 hour average DVS and RCM8 magnitudes. A plot of this comparison is contained in Figure 8.

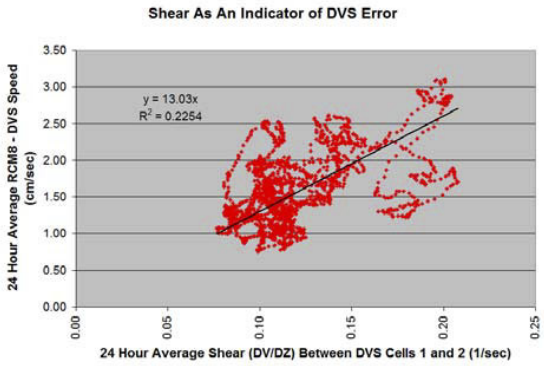

Figure 8: Scatter Plot of Average Shear in the DVS data relative to the average difference between DVS and RCM8.

There was a 0.39 coefficient of correlation between the data in figure 8. This moderate correlation could indicate that there was a potential mooring line influence on the velocity that was measured by cell 1 where the beam separation was smallest but also that there could be other factors involved in the discrepancy between the DVS and RCM8 measurements. This method of Data Quality assurance should be investigated in other DVS datasets.

CONCLUSION:

The measured DVS current velocities compare well with the measured Currents from a historical standard rotor current meter. Use of shear between nearby velocity measurements cells in the DVS appears promising as a qualitative data quality estimator.